APPLICATION UNDER UNITED STATES PATENT LAWS

Invention: M-SHAPED BOAT HULL

Inventor(s): CHARLES W. ROBINSON
WILLIAM F. BURNS III

Pillsbury Madison & Sutro LLP
Intellectual Property Group
1100 New York Avenue, N.W.
Ninth Floor, East Tower
Washington, D.C. 20005-3918
Attorneys
Telephone: (202) 861-3000

This is a:

- ☐ Provisional Application
- ☒ Regular Utility Application
- ☐ Continuing Application
- ☐ PCT National Phase Application
- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application
- ☐ Substitute Specification
  Sub. Spec. filed ______
  in App. No. _____/_____
- ☐ Marked Up Specification re
  Sub. Spec. filed ______
  in App. No. _____/_____

SPECIFICATION

M-Shaped Boat Hull

Field of the Invention

This application claims the benefit of copending U.S. Provisional Application Serial No. 60/101,353 filed September 22, 1998.

The present invention relates to an "M-shaped" hull design for a watercraft (e.g., motorboat or sailboat) which suppresses wave action compared to conventional hull designs.

Background of the Invention

Motor and sail powered displacement boats generate a bow wave, followed by a trough and stern wave, due to hull form and friction. For a displacement boat, the bow wave increases in amplitude with boat speed until propulsion power is insufficient to climb the wave (i.e., the hull speed limit). The bow wave, when generated, initially moves forward at the hull speed, but eventually loses speed and moves at an angle away from the hull. When the bow wave does so, it has sufficient energy to threaten other nearby boats and cause damage to foundations at the water/land interface in narrow waterways. In addition, engines mounted on the stern of the boat generate strong propeller wave action and noise pollution, which are especially objectionable to residences and/or commercial buildings located near the water/land interface. These problems are accentuated when boats operating at low speeds are required to make sharp-angle turns in narrow waterways, such as in the canals of Venice, Italy. Because a rudder is less effective under such conditions, an articulating outboard motor (or propeller), which accentuates the generation of waves and noise pollution, may be required.

The problems associated with the operation of smaller displacement boats powered by stern-mounted internal combustion engines include:

1. Conventional power boats are designed as either: (a) displacement boats, efficient at low speeds but subject to hull speed limits; or (b) planing boats, inefficient at low speed but with sufficient power and planing surface to transcend the hull speed limits;

2. As mentioned above, bow waves generated by a boat move forward initially at the boat speed, but thereafter at decreasing speed due to friction, leading to potentially destructive bow waves moving laterally away from the boat;

3. A significant portion of propulsion energy is lost when converted into wave energy, leading to inefficiency;

4. Bow and stern waves plus stern-mounted propeller wave action generated by boats operating at high speed can cause serious damage to other boats and to foundations at the water/land interface in narrow waterways and small lakes; and

5. Wave, noise, and air pollution generated by conventional displacement boats powered by internal combustion engines are accentuated with an articulating outboard motor or propeller.

Summary of the Invention

It is a general objective of the present invention to minimize damage to foundations at the water/land interface and to reduce the disruptive heaving motion to waterborne vessels and structures from boat-generated waves through operation of a watercraft having an approximately "M-shaped" hull that is designed to suppress such wave action.

It is a further objective in certain embodiments of the present invention to provide a powerboat having a relatively narrow central displacement body and planing wings to operate efficiently at low speed in the displacement mode, while requiring less power for efficient transfer into the planing mode, thereby providing efficient planing at high speed.

It is a further objective in other embodiments to recapture boat-generated waves through extension from the central displacement body of planing wings and parallel tapered outer skirts having vertical outboard and curved inboard surfaces to direct both the bow and skirt waves into channels in the planing wings.

It is a further objective to recover energy from the boat-generated waves (which are recaptured by the wing channels and tapered outer skirts) through planing on these waves, thereby recovering some portion of their contained energy.

It is a further objective in certain embodiments to provide improved stability at low boat speeds by installing at the outer edge of the planing wing a tapered outer skirt extending downward below the water line.

It is a further objective in certain embodiments to provide inner skirts attached to both sides of the displacement body to aerate the water along the hull to reduce frictional drag and to minimize wave energy behind the boat.

It is a further objective to increase dispersion of the wave energy exiting the boat by installing hydrodynamic serrations on the underside of the displacement body and/or the wing channels, preferably generally aligned with the outer and inner skirts and propeller discharge.

It is a further objective to reduce noise and air pollution by replacing transom-mounted engines with internal combustion, electric, or compressed air motors mounted in the wing channels and/or on the central displacement body.

It is a further objective to adapt the "M-shaped" hull to a sailboat with twin wing channels to provide righting moment from the higher lee-side bow wave and an automatic adjustment of side force with increasing immersion of the lee-side skirt.

The foregoing objectives are achieved by using an "M-shaped" watercraft hull. The present invention provides in certain embodiments a watercraft comprising a hull having a fore end, an aft end, and a longitudinal axis extending between the fore end and the aft end. The hull comprises a displacement body and two downwardly extending outer skirts. Each of the outer skirts is located outside of the displacement body and is connected thereto by a planing wing having a wing channel. The ceilings (i.e., apices) of the wing channels are above the static waterline in the fore end and extend downward below the static waterline in the aft end. Preferably, the displacement body is approximately centralized, extending substantially along the central longitudinal axis of the hull. The wing channels are preferably generally arcuate and concave with respect to the static waterline.

Brief Description of The Drawings

Figure 1 shows a plan view of an "M-shaped" powerboat hull, depicting large bow waves, small skirt waves, planing wings, "spiral channel" sections on the planing

wings, a central displacement body, tapered outer and inner skirts, wing channels formed in the planing wings, and hydrodynamic serrations, both on the central displacement body and in the wing channels.

Sub A1 Figure 2A shows a powerboat hull profile, depicting a central displacement body and tapered outer skirts that capture the bow wave, and the line of the planing wings that suppress and recapture wave energy.

Sub A2 Figure 3 shows the powerboat hull section, depicting the central displacement body with wing channels and tapered outer skirts to capture and suppress the bow wave. Figure 3A shows twin motors in the wing channels; Figure 3B shows twin motors on the displacement body; and Figure 3C shows a single motor on the displacement body.

Figure 4 shows a plan view of an "M-shaped" sailboat hull, depicting a central displacement body, planing wings and tapered skirt for side force and bow wave capture.

Figure 5 shows a sailboat hull profile view, depicting the central displacement body, planing wings and tapered outer skirts for side force and bow wave capture.

Figure 6A shows the sailboat bow section depicting the wing channels, wing channel ceilings, central displacement body and skirts curved outwards at the tip to enhance side force; Figure 6B shows the mid-section depicting the bow wave; and Figure 6C shows the aft section.

Figure 7 shows the sailboat heeled mid-section, depicting the skirt increasing side force with heel; greater bow wave righting moment; and the lesser bow wave.

Detailed Description of Preferred Embodiments of the Invention

The present invention is predicated on the realization that a boat propelled by motor or sail generates bow waves containing energy. With a conventional hull design, this energy is not only lost, thereby reducing efficiency, but also threatens other boats and damage to structures at the water/land interface. The "M-shaped" hull of the present invention recaptures the bow waves not only to protect other boats and structures at the water/land interface, but also to enhance boat efficiency. In the following detailed description, certain preferred embodiments of the present invention are described structurally first and then the general operation is provided.

5

Sub A3 Referring initially to FIGS. 1 and 2, the present invention provides a powerboat comprising an "M-shaped" hull 1 having a fore end 2, an aft end 3, and a longitudinal axis extending between the fore end and the aft end. The hull 1 comprises a displacement body 16, which is preferably relatively narrow and centralized, and two downwardly extending outer skirts 18. The outer skirts 18 are preferably generally parallel. The displacement body 16 provides displacement lift for efficient operation at low speeds. Each of the outer skirts 18 is located on either side of the displacement body 16. Lateral extensions of the watercraft deck outward from the central displacement body 16 form two planing wings 20. The planing wing line 21 is shown in FIG. 2. The outer skirts 18 are connected to the displacement body 16 by the planing wings 20, which have wing channels 14. The bow waves 10 and the smaller skirt waves 12 are directed into the wing channels 14, wherein the waves undergo spiral action.

Sub A4 The outer (i.e., outboard) surfaces of the outer skirts 18 are preferably substantially perpendicular with respect to the static waterline 5 to minimize wave generation. The outer skirts are also preferably generally arcuate (i.e., curved) on their inner surfaces (i.e., inboard), so as to form arcuate wing channels 14 with the displacement body 16. Most preferably, the outer skirts 18 are tapered. In operation, the wing channels 14 recapture the bow waves 10, thereby protecting other boats and waterway walls and providing effective planing surfaces 22 for efficient operation at high speed.

Sub A5 In preferred embodiments (see FIGS. 3A-C), the cross-sectional surface of each wing channel 14 is concave with respect to the static waterline. More preferably, the cross-sectional surface of each wing channel 14 at the fore end is generally arcuate. Preferably, the curvature of the cross-sectional surface of each wing channel 14 is greater at the fore end than at the aft end. The curvature preferably progressively decreases from the fore end to the aft end. In particularly preferred embodiments, the cross-sectional surface of each wing channel is generally arcuate at the fore end and generally linear (i.e., "flat") at the aft end. The wing channel ceilings 30 (i.e., apices) are above the static waterline in the fore end and extend downward below the static waterline in the aft end.

Sub A6 Referring again to FIG. 1, the watercraft of the present invention may have a hull 1 that further comprises two or more downwardly extending inner skirts 26 attached to

Ale contd

either side of the displacement body 16, wherein the outer skirts 18 flank the inner skirts 26. In certain embodiments, as described in greater detail below, these inner skirts 26 can reduce cavitation caused by propeller action.

Sub a7 ~~Preferably, the hull 1 further~~ comprises one or more hydrodynamically-shaped serrations 24 located on the surface of the wing channels 14 (at the aft end 3) and extending downward below the static waterline 5. The one or more serrations are preferably located on the wing channel ceiling (see 30 in FIG. 3). Alternatively, the hull may further comprise one or more hydrodynamic serrations 25 located on the surface of the displacement body 16 and extending downward below the static waterline 5. The serrations 24 and 25 provide wake control. To more effectively disperse both the remaining bow wave energy exiting from the wing channels 14 and the propeller wake energy, the hydrodynamically-shaped serrations are preferably mounted under, and extend forward of, the transom which is generally aligned with the outer and inner skirts and propeller(s) discharge. This design disperses the wave flow and increases the mixing of air and water, with the air dampening the transmission of energy in the water, thereby further reducing the threat to other boats or damage to structures at the water/land interface.

Sub a8 The present invention also provides in certain embodiments a watercraft wherein upon forward movement of the watercraft through a body of water, the waves generated by the displacement body 16 and the outer skirts 18 are substantially directed into the wing channels 14, resulting in substantial wave suppression.

Sub a9 The watercraft of the present invention may be a powerboat (as illustrated in FIGS. 1-3) or a sailboat (as illustrated in FIGS. 4-7). Where the watercraft is a powerboat, the watercraft preferably comprises a mechanical propulsion system. The mechanical propulsion system may be an internal combustion system, an electrical system, a compressed air system, or a combination thereof. Preferably, the mechanical propulsion system comprises one or more propellers. Referring to FIG. 3, the propeller(s) 50 may be located on the displacement body 16 (see FIGS. 3B and 3C) or on a planing wing (e.g., in a wing channel). In the case where the propellers are located in the wing channels (see FIG. 3A), it is preferred that there be two propellers, wherein each of the two propellers is located in a wing channel 14.

~~Twin propellers 50 mounted below the wing channels 14 provide efficient~~ propulsion and maneuvering at lower speeds, as in FIG. 3A. However, with increased speeds, the turbulent air/water mixture, which is desirable for lift efficiency in the wing channels 14, also creates propeller cavitation. To resolve this cavitation problem, the air/water mixture flowing through the wing channels 14 can be isolated for increased lift efficiency by installing two inner skirts 26 (preferably generally perpendicular to the static waterline and parallel to the outer skirts), as illustrated in FIG. 1. Preferably, the inner skirts 26 are faired into the central displacement body 16 near the point of its maximum beam and extend beyond the propeller(s), thereby forming an inner wall to contain the air/water mixture. This inner skirt design assures solid water flow under the central displacement body 16 in which either a single (see FIG. 3C) or twin propellers (see FIG. 3B) may operate efficiently at higher speeds without cavitation. For propellers mounted on the central displacement body 16, satisfactory boat maneuvering may be achieved with a large single rudder directly aft of a single propeller or twin rudders mounted in the discharge from the two propellers, in either case mounted forward of the transom. Alternatively, where two propellers are used, maneuverability may be ~~controlled by separate control of speed and direction of rotation for each propeller.~~

Having described the structure of various preferred embodiments of the present invention, the operation of such watercraft is described below. In operation, the bow waves 10, which are moved forward by the boat at its speed, are forced into the wing channels 14 and given a spiral motion by the concave surface of the wing channels 14. The water then spirals back through the wing channel with reduced angularity as its forward speed is slowed by friction. Air near the entrance to the wing channel, increasing in pressure with boat speed, is entrapped in the water spiral which acts as a screw conveyor, moving the air with the water in a spiral pattern through approximately the first two-thirds of the length of the wing channel 14 referred to as the "spiral section." Although its speed is reduced by friction, the air/water mixture continues to move forward in relation to water outside the wing. This water action contributes to efficient planing lift on the ceilings of the wing channels, with the air content also providing a benefit in reduced friction drag.

Sub a12 As the air/water mixture leaves the "spiral section" (see 14 in FIG. 1), it passes into the final approximately one-third of the wing channel that, in certain preferred embodiments, becomes increasingly rectangular with a flattening (e.g., decreased curvature) of the wing channel ceiling. The wing channel ceilings slope downward to below the static waterline, reducing and ultimately eliminating the cross-sectional area, thereby increasing the pressure of the air/water mixture. These changes in what is referred to as the "pressure section" (see 22 in FIG. 1) eliminate the spiral flow and force separation of the air which rises towards the wing channel ceiling due to its lower specific gravity. The water, under increasing pressure, compresses the air layer at the wing channel ceiling, thereby providing efficient low-drag planing lift. Finally, the compressed air/water mixture exits under the transom as low energy foam, while the lower solid water layer, from which much of the energy has been extracted in compressing the air, exits the transom below the foam.

Sub a13 As mentioned above, the hull design provided by the present invention can also be adapted for use in a sailing vessel, as shown in FIGS. 4-7. A sailboat design incorporating an "M-shaped" hull 100 having a sailing mast 101 is illustrated in FIG. 4. Referring to FIGS. 4-7, such a sailboat has the following features:

1. A narrow displacement body 116 for efficient sailing at low speeds;

2. Planing wings 120 with ceilings 130 to provide stability from bow waves 112 and to promote planing;

3. Righting moment from the lift on the lee-side bow wave 112a on the wing ceiling 130, which increases with boat heel (lesser bow wave 112b and greater bow wave 112a, which increases the righting moment, are shown in FIG. 7);

4. Outer skirts 118 (preferably tapered) to contain the bow wave 112 and provide automatic adjustment of side force with heel and increasing immersion of the skirt having a curved tip to enhance side force (see FIG. 7); and

5. Wing ceiling 130 sloped downward aft to the transom for efficient planing ~~(see FIG. 6).~~

Sub a14 As with the powerboat embodiments described above, hydrodynamic serrations 124 may be mounted on the underside of the sailboat hull 100. As shown in FIGS. 6A-6C, the wing channel ceilings 130 preferably decrease in height and the curvature of the

a14 cont'd

wing channels 114 decreases, moving from the bow section (FIG. 6A) to the mid-section (FIG. 6B) to the aft section (FIG. 6C). As shown in FIG. 6C, the outer skirts 118 preferably decrease in length toward the aft end of the hull to provide efficient planing surfaces.